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Success Story

LAB DISCOVERS NEW POLYATOMIC NITROGEN COMPOUND

Researchers from the Propulsion Directorate's High Energy Density Matter (HEDM) team have achieved a breakthrough in polyatomic nitrogen chemistry that may allow future advances in high-energy rocket propellants or explosives.

Air Force Research Laboratory
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Accomplishment

Drs. Karl O. Christe and William W. Wilson of the Air Force Research Laboratory's HEDM team announced the discovery of a N5+ cation combined with the AsF6- anion (N5+AsF6-) at the 14th Winter Fluorine Conference of the Division of Fluorine Chemistry of the American Chemical Society held in Florida. This discovery, a breakthrough in polyatomic nitrogen chemistry, may assist researchers find and produce new high-powered rocket propellants or additives that exceed current capabilities for use in future Air Force systems. Dr. Christe devised the synthesis of the compound (N5+AsF6-) while Dr Wilson was able to produce macroscopic amounts with high yield and purity. Considering the cation's calculated heat of formation of 353kcal/mol, the white solid compound is surprisingly stable. Dr. Christe and his fellow researchers envision additional molecules with greater stability and potential for the future. For example, the new cation might be combined with an energetic anion to yield a highly energetic propellant or explosive ingredients. The researcher's interest in using these compounds for propellants comes from the compound's ability to provide energy from the production of nitrogen molecules.

Background

Nitrogen (known to chemists as diatomic molecular nitrogen) makes up 80 percent of the earth's atmosphere, whereas polyatomic nitrogen molecules or ions, which contain only nitrogen atoms, are very rare and unique. In 1772, notable chemists of the time, Rutherford, Scheele, and Cavendish isolated pure nitrogen from air. Since that time, only one polynitrogen compound, an azide anion, has been discovered (1890 by Curtius) and produced in bulk form. The Lab's HEDM team, led by Dr. Pat Carrick, validated and verified all aspects of the new and novel molecule. Drs. Jerry Boatz, Jeffrey Sheehy, and Mario Fajardo provided important theoretical and spectroscopic data from lab tests that agreed with information obtained from Mr. Alan Kershaw at USC and Dr. John Stanton at the University of Texas, Austin. The HEDM team also used previous calculations made by Drs Pyykkoe and Runeberg from the University of Helsinki – Finland. The HEDM team collaborated with the Loker Hydrocarbon Research Institute and Chemistry Department at the University of Southern California, where Dr Christe guides a separate research group funded by the National Science Foundation. The Defense Advanced Research Project Agency (DARPA) and Dr. Mike Berman of the Air Force Office of Scientific Research (AFOSR) partially support HEDM research at the lab.

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Additional information

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